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<b>(54) Title:</b> PURSE STRING SUTURE APPARATUS  <div data-bbox="277 1165 1344 1379" data-label="Image"> </div> <b>(57) Abstract</b> <p>The purse string suture apparatus (PSSA) comprises lips (1, 2) for hollow organ compression and formation, thread (17), and needles (8, 9) for its running through hollow organ walls. In doing this, the piercing direction (50) of hollow organ walls by needles (8, 9) is opposite to the direction of subsequent thread passing (51) through said walls. It results in prevention of exit of open pricking needle tips (10, 11) outside the PSSA bounds, and ensures exit of thread ends proximally of hollow organ. In the PSSA starting position, the needles (8, 9) are located proximally, and thread ends (18, 19) distally of hollow organ. PSSA is equipped with the means (20, 21) for connection of needle tips and thread upon needle displacement into extreme distal position, with the means (75) for detachment of thread ends from PSSA, and with the means for the thread fast placing into PSSA. The modifications for open and endoscopic surgery are available.</p>		

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PURSE STRING SUTURE APPARATUS

## FIELD OF THE INVENTION

The invention relates to medical equipment, in particular to apparatuses for purse string suturing of hollow organs.

## BACKGROUND OF THE INVENTION

At present such apparatuses for purse string suturing of hollow organs are widely used that include jaws capable of straining hollow organ walls. The jaws have through longitudinal guiding orifices wherein two needles are alternately entered from proximal side, those needles in their tail part are connected to thread ends. These needles assist in manual or by means of auxiliary tool (forceps) alternate stitching of jaw-compressed serous-muscular layer of hollow organ wall by needle and thread. As the result, needle ends protrude from the apparatus distal side where they are grasped by auxiliary tool and drawn out of the apparatus, thus drawing the thread ends through hollow organ walls outside. Then the thread ends are released from needles and afterwards purse string is sutured by surgical apparatus with their assistance and tied manually (as a rule, by several knots), thus fastening purse string suture in such a manner that said suturing and tieing occur from the distal side of purse string suture.

This apparatus has the drawbacks as follows.

The necessity to draw relatively long needles on apparatus distal side and to provide space for their exit create

considerable operation inconveniences, in particular, in hard-to-reach anatomical areas and complicated surgical situations. These conditions also hinder purse string suture tight knotting and tying from distal side of hollow organ. Said needle exit from the apparatus distal side is open to the hazard of adjacent tissue injuries by the needle sharp pricking end. Besides, the hazard of medical staff pricking and infecting also exists. Manual tying of knotted purse string suture, need in auxiliary tool, alternation (inconcurrency) of needle drawing through jaws, manipulation inconveniency on the suture reverse (distal) side, necessity of being careful to avoid patient and personnel injury by needle open pricking tips - all these condition considerable difficulties in purse string suturing. Said drawbacks are revealed in open surgery, but in endoscopic operations, in particular.

An apparatus for purse string suturing of hollow organs is known from the USA patent No. 4915107, wherein needles made of thin resilient wire with sharp pricking tips are mounted on an actuator-equipped drum. Needle ends are fixed in needle tail section. Drum with actuator permit to ease and make more comfortable the needle and thread stitch drawing through serous-muscular tissue of hollow organ wall strained by the apparatus jaws. The process is executed by two needles simultaneously, which decreases labor input. But the apparatus has all above indicated demerits associated with manipulation on the suture distal side, with utilization of auxiliary instruments and with hazard of injuries. So the apparatus actually solves no problems of purse string suturing in

endoscopic surgery. Besides, relatively intricate apparatus charging with flexible needles and thread hinders the implementation of the same apparatus for making several purse string sutures in the same surgery, in particular in hollow organ anastomosis.

#### SUMMARY OF THE INVENTION

The invention objective is improvement of operation conveniency in hard-to-reach anatomical areas of fixed organs and in intricate surgical situations.

Another invention objective is precluded possibility of patient body injury by needle pricking tips.

Another invention objective is precluded possibility of a chance pricking and medical personnel infection.

Another invention objective is decrease in time consumption for purse string suturing.

Another invention objective is potential implementation of the same apparatus for making several purse string sutures during a single surgery.

Another invention objective is enhancement in quality and conveniency of endoscopic surgeries.

The indicated objectives are achieved owing to the following design features:

A apparatus for purse string suturing of hollow organ which being mounted inside the apparatus has two lateral sides, comprising:

- purse string suture (PSS) which is drawn through the walls of hollow organ;
- means for stitch pricking of hollow organ wall and

stitch drawing of PSS through this wall;

- direction of stitch pricking;
- direction of PSS stitch drawing through orifices in hollow organ wall, generated by stitch pricking;
- so that direction of PSS stitch drawing is opposite to the direction of stitch pricking.

Alternative apparatus embodiment, wherein:

- PSS has ends;
- means for stitch pricking and PSS stitch drawing include piercing means;
- working zone is available wherein stitch pricking of hollow organ wall and stitch drawing of PSS ends through it are performed;
- initial position is found, when PSS ends are located on one side of working zone, whereas piercing means, on its opposite side.

Alternative apparatus embodiment, wherein:

- there is a pair of jaws and within their bounds working zone is situated so that clamping of hollow organ between jaws takes place for stitch pricking of its wall and PSS stitch drawing;
- jaws and working zone have proximal side whereon stitch pricking of the wall of hollow organ originates, and distal side whereon stitch drawing of PSS ends originates;
- in initial position PSS ends are situated from distal side of jaws, whereas piercing means are situated from proximal side of jaws outside working zone.

Alternative apparatus embodiment, wherein:

- piercing means are made as two needles;

- there are connecting means for connection of PSS ends and needles.

Alternative apparatus embodiment, wherein there are needle ways in jaws where each needle has pricking tip with adjacent finite distal section of needle, whereas needles, jaws and PSS ends are situated relative to each other in the following manner:

- first position, which is initial position: the needles are positioned outside and more proximally of working zone;

- second position, which is extreme distal position of the needles: the needles are partially positioned inside the working zone and pricking tips of needles and finite distal parts of needles are located more distally of working zone and are connected to PSS ends:

- third position which takes place after return of needles from second position: needles and PSS ends drawn through hollow organ wall are located more proximal of working zone.

The apparatus proposed enhances surgeon's work convenience as PSS ends are drawn to the intestine proximal side that is more accessible for the surgeon and more practicable for further tying of PSS. It is particularly important for operation on hard-to-reach organs in complicated surgical situations when organ access is limited. Therefore, these apparatus features are appreciable in endoscopic manipulations. Besides, when operating the apparatus, there is no hazard of patient or personnel injuring by pricking tips of piercing means.

Alternative apparatus embodiment, wherein connecting means

are made as two pairs of members, each of them comprising needle finite distal part and connector, wherein distal part is the fixation point of PSS end, whereas proximal part is adapted to engaging with needle finite distal part.

Alternative apparatus embodiment, wherein said engagement of connector and needle finite distal part is made on male-female principle.

Alternative apparatus embodiment, wherein proximal part of connector is tubular and operates as female member, whereas needle finite distal part is male member.

Alternative apparatus embodiment, wherein engagement of needles and connectors takes place owing to friction forces.

The apparatus of such kind are easily manufactured, cheap, compact and user-friendly.

Alternative apparatus embodiment, wherein there are engagement means for engaging needles with connectors so that engagement means comprise at least one recess and one protrusion and so that one of them is situated on needle finite distal part, while the other one, on connector.

This design modification has enhanced engagement reliability, as it insignificantly depends on substance (for instance, blood) presence on engaging surfaces that may serve as counter-friction coatings.

Alternative apparatus embodiment, wherein there are seat buckets for installation of connectors inside them, and the connectors are situated more distal of working zone.

The presence of special seat buckets for connectors increases the apparatus operation reliability and facilitates connector mounting.



Alternative apparatus embodiment, wherein the couplings of connectors and needles are undetachable.

This link between connector and needle precludes failures in apparatus operation caused by connector chance disconnection of the needle.

Alternative apparatus embodiment, wherein the coupling of connectors and needles is made detachable and their disengagement occurs more proximal of working zone during their movement from the second position to the third position so that progress of needles upon motion is larger than connector progress by at least axial overlapping value of needles and connectors in their second position.

Alternative apparatus embodiment, wherein there are means for disconnection of connectors and needles, located more proximal of working zone.

Alternative apparatus embodiment, wherein means for disconnection of connectors and needles comprise releasing members for disconnection of connectors and needles.

When the connector engagement to needle is made disconnectible, it considerably increases operation conveniency, as no necessity in thread end disengagement by special additional methods arises.

Alternative apparatus embodiment, wherein said releasing members are rigid, made as steps adapted to engagement with said connectors with the force sufficient for removal of connectors from needles.

Making the releasing members rigid significantly simplifies and cheapens the design and ensures the apparatus reliable operation.

Alternative apparatus embodiment, wherein releasing members are made elastic and comprise engaging edges adapted to engagement with connectors for its removal from needles.

Such design embodiment of releasing members permits working with connectors whose outer diameter does not exceed the needle diameter, and such correlation between diameters makes the design atraumatic for drawing through hollow organ wall.

Alternative apparatus embodiment, wherein there is a stripper removably installed in the apparatus and adapted to: confinement of connectors with PSS ends in connectors following disconnection of these latter from needles; removal of connectors with PSS ends from the apparatus and PSS drawing through hollow organ walls; and containing keeping members preventing backward exit of connectors with PSS ends out of stripper following their disconnection of needles, and there is a bucket for stripper made as a recess in apparatus members.

Presence of a special member - stripper - designed for removal of disconnected PSS ends from the apparatus upgrades operation convenience, since the inconveniency of removal of relatively small-size connectors out of the apparatus is eliminated. Besides, stripper permits to remove two connectors at once from the apparatus, simultaneously with drawing both thread ends through hollow organ wall. Such operation sequence precludes possible PSS entanglement.

Alternative apparatus embodiment, wherein keeping members look like spring-loaded members shutting backward exit of connectors following their entering the stripper and made as,

for instance, springy-steel bended plate members.

Alternative apparatus embodiment, wherein releasing members are situated inside the stripper.

Alternative apparatus embodiment, wherein keeping members are at the same time releasing members and are made as, for instance, cone-shaped channels with their widened side directed distally, and adapted to embedding of connectors inside them.

In this embodiment cone-shaped channels perform two immediate functions of keeping members and of releasing members, thus making the design straightforward, low-cost, and easy-to-manufacture.

Alternative apparatus embodiment, wherein engagement forces of connectors with releasing members are larger than engagement forces of needles and connectors, whereas engagement forces of needles and connectors are larger than any forces counteracting the movement of connectors upon progress of needles from the second position to the third position until the moment of connectors and releasing members interaction.

Alternative apparatus embodiment, wherein there are means promoting achievement of extreme distal position by needles in the second position, and thus ensuring reliable connection of PSS ends and needle finite distal parts.

The necessity of such means is related to the fact that if the needles extreme active position are not achieved, poor connectors and needles engagement are possible, and then, by needle passing into third position, the connectors may prematurely get disconnected of the needles, while still being

within organ wall bounds. Such chance disconnection may result into repeated purse string suturing, which both needs additional time and leads to additional hollow organ injury.

Alternative apparatus embodiment, wherein there are support surfaces on immovable members, and movable support surfaces on its movable members connected with needles upon their progress from the first position into the second one so that movable support surfaces during needle progress move toward immovable support surfaces and they abutt each other in extreme distal position of needles.

The presence of support surfaces increases operation convenience, since when one support surface abutts another one it is felt by a surgeon and indicates that the needles reached their second position.

Alternative apparatus embodiment, wherein there are means for interlocking the proximal displacement of needles towards their third position until the needles reach their extreme distal position in second position but so that said interlocking means act at least in distal portion of said needle progress limited by their first and second positions; as well as means for unlocking the said needle proximal displacement.

Alternative apparatus embodiment, wherein said interlocking means are made as a ratchet comprising rack and pawl, one of them being spring-loaded.

Such design embodiment ensures absolute apparatus reliability, moreover the operation sequence preset by the design cannot be intervened by user.

Such embodiment of interlocking means is simple, low-cost

and failure-proof. No new pieces are introduced even when the available ones become more involved. The locking mechanism actuates automatically thus increasing operation convenience for surgeon, as he is not distracted by actuation control.

Alternative apparatus embodiment, wherein there are means for achievement of extreme proximal position by the needles in their third position.

Alternative apparatus embodiment, wherein there are support surfaces on apparatus immovable members, and movable support surfaces on its movable members connected with the needles upon its movement from the second position into the third one so that movable support surfaces during said needle progress move toward immovable support surfaces and they abutt each other in extreme proximal position of the needles.

Presence of said means in the apparatus promoting achievement of extreme proximal position by the needles ensures:

- removal of needles from the working zone which is required for hollow organ elimination out of apparatus;
- removal of needles to the position where they do not prevent separation of the apparatus jaws;
- connector elimination from the needles in detachable version of connector-needle assembly;
- unhindered removal of a stripper from apparatus;

With such apparatus design surgeon's work is facilitated, as he has the possibility of objective control over operation of the apparatus individual units.

Alternative apparatus embodiment, wherein there is an apparatus casing containing said jaws in its distal part, and

the needles are located in apparatus casing more proximal of working zone upon initial position; the casing comprises guides and actuator for said piercing means as well as control means for said jaws.

Alternative apparatus embodiment, wherein actuator is removable and comprises: actuator casing; actuator casing handle; pusher for transmission of effort to piercing means; as well as control means for the jaws.

Such apparatus design permits, by using one removable actuator and mounting it onto detachable apparatus units, to implement it during the same surgery for several purse string sutures, thus reducing the surgery costs.

Alternative apparatus embodiment, wherein there is a separate, set removably in the apparatus, member whereon PSS and connectors are mounted.

Possibility of apparatus recharging by PSS with connectors permits to make several purse string sutures within the same surgery and by the same apparatus.

Alternative apparatus embodiment, wherein stripper is equipped with knife for cutting PSS and their liberation in manner from stripper and connectors.

#### BRIEF DESCRIPTION OF THE DRAWINGS

For more complete understanding of the invention its detailed description is made with references to the Figures wherein:

Fig. 1 shows the proposed purse string suture apparatus in assembly with removed actuator in a before operation position; the apparatus may be used for endoscopic surgery.

Fig. 2 shows the 2-2 section of the drawing shown in Fig. 1.

Fig. 3 displays the 3-3 section of the drawing shown in Fig. 2, illustrating design of the jaws.

Fig. 4 shows the 4-4 section of the drawing shown in Fig. 2, illustrating design of the jaws.

Fig. 5 shows the fragment of the apparatus proposed without actuator as a portion of the apparatus shown in Fig. 1.

Fig. 6 shows the drawing of detachable actuator in assembly as a portion of the apparatus shown in Fig. 1.

Fig. 7 shows the drawing of assembled apparatus proposed with detachable actuator at the initial work stage, in first position; the apparatus may be used for endoscopic surgery.

Fig. 7 displays enlarged-scale fragment of Fig. 7 drawing illustrating the connector and PSS layout in the apparatus.

Fig. 10 shows the drawing of assembled apparatus proposed with detachable actuator during operation in second position; the apparatus may be used for endoscopic surgery.

Fig. 9 displays enlarged-scale fragment of Fig. 10 illustrating needle distal finite sections connection to connectors.

Fig. 11, 12 has the drawings of the apparatus alternative embodiment as two branches.

Fig. 13 shows 13-13 section of the apparatus shown in Fig. 12, without stripper.

Fig. 14 shows 14-14 section of the apparatus shown in Fig. 13, without stripper.

Fig. 15 displays longitudinal section of the apparatus

shown in Fig. 14 with installed stripper.

Fig. 16 displays transversal 16-16 section of the apparatus shown in Fig. 13 and illustrates the design of the apparatus jaws.

Fig. 17 displays transversal 17-17 section of the apparatus shown in Fig. 13 and illustrates the design of thread bend exit area upon stripper removal.

Fig. 18 shows fragment of the apparatus shown in Fig. 15 illustrating stripper with inside connector, thread and needle finite distal section.

Fig. 19 shows fragment of the apparatus shown in Fig. 15, illustrating stripper with connector following connector disengagement with needle.

Fig. 20 gives general view of the stripper which is the component of the apparatus from Fig. 15.

Fig. 21 gives view B of the stripper shown in Fig. 20.

Fig. 22 shows 22-22 section of the stripper given in Fig. 21 and illustrates releasing and keeping members located inside the stripper.

Fig. 23 shows 23-23 section of the stripper given in Fig. 21 and illustrates design of the knife located inside the stripper.

Fig. 24 shows 24-24 section of the stripper given in Fig. 23 and additionally illustrates design of the knife located inside the stripper.

Fig. 25 shows 25-25 section of the stripper given in Fig. 22 and illustrates mutual disposition of knife and releasing and keeping members located inside the stripper.

Fig. 26 shows apparatus fragments in initial position with



inside, located-on-needles stripper, having springy releasing and keeping members.

Fig. 27 demonstrates 27-27 section of the apparatus shown in Fig. 26.

Fig. 28 shows apparatus fragments in initial position with inside, located-on-needles stripper, having springy releasing and keeping members, and with connectors and needle distal finite sections mounted inside the stripper, before their separation.

Fig. 29 shows 29-29 section of the apparatus shown in Fig. 28.

Fig. 30 gives the drawing of stripper with spring-loaded releasing and keeping members, with inside stripper located connectors, following their disconnection with the needles.

Fig. 31 shows the apparatus fragment with inside, located-on-needles stripper, having keeping members as circular conical protrusion on channel inner surfaces for connector entry; the releasing members are located on the apparatus housing.

Fig. 32 shows 32-32 section of the apparatus given in Fig. 31.

Fig. 33 shows drawing of the stripper in the modification given in Fig. 31, following connectors and needles disengagement and stripper removal out of the apparatus.

Fig. 34, 35 shows general view drawings of PSS with coil and connector assembly as a portion of the apparatus shown in Fig. 13.

Fig. 36 shows the housing distal part fragment of the apparatus shown in Fig. 13 and intended for mounting of PSS

coil unit and connectors inside it.

Fig. 37 shows upper view of the drawing Fig. 36.

Fig. 38 shows the 38-38 section of the drawing Fig. 36.

Fig. 39, 40 shows the drawings of general view of the needle hub which is the part of the apparatus shown in Fig. 11-15.

Fig. 41 shows the 41-41 section of the hub given in Fig. 40.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 shows assembled apparatus for purse string suturing of hollow organ with detachable actuator in a before-operation position. The apparatus has the means for stitch pricking of hollow organ wall and stitch drawing of PSS through it comprising a pair of jaws 1 and 2 with indented surfaces 3, 4, intended for hollow organ compression between them. Within the 3, 4 surfaces the apparatus working zone 5 is situated between its proximal 6 and distal 7 borders. Stitch pricking of hollow organ wall and stitch drawing of PSS through it is made between borders 6 and 7. Said means also comprise piercing means as needles 8 and 9 with pricking ends 10 and 11, respectively, whereto finite distal sections of needles 12 and 13 are adjoint, respectively. Needles 8 and 9 have on their proximal ends common hub 14. Removable coil 16 with wired PSS 17 as a single thread, having ends 18 and 19, and connectors 20 and 21, wherein distal ends are connected to ends 18, 19 of PSS 17 is situated in jaw 1 more distal of working zone 5 in bucket 15. Connectors 20, 21 are intended for connection of ends 18, 19 of PSS 17 and distal finite

sections of needles 12 and 13, respectively. Jaws 1 and 2 have needle ways 22 and 23 with needle guides 24 and 25 so that in needle guide 24 one end 18 of PSS 17 is drawn by one needle 8 whereas in needle guide 25 one end 19 of PSS 17 is drawn by one needle 9. Slits 48, 49 are also made in jaws 1, 2 for PSS bend passing.

Jaws 1, 2 and working zone 5 have proximal side indicated by proximal border 6 and distal side indicated by distal border 7. The apparatus proposed has hollow organ stitch pricking direction 50 by needles 8 and 9 from proximal border 6 to distal border 7, as well as stitch drawing direction 51 of ends 18, 19 of PSS 17 through orifices in hollow organ wall generated by said stitch pricking, from distal border 7 to proximal border 6. Therefore, said directions of stitch pricking and stitch drawing of PSS are opposite. The apparatus has housing 26, wherein there are guides 27 for hub 14 as well as guides 28 and 29 for needles 8 and 9 respectively. Hub 14 is movably mounted in guides 27 and has fixing circular conical protrusion 30 interacting with conical recess 31 in apparatus housing 26 and preventing proximal displacement of hub 14 and needles 8, 9 to the position indicated in Fig. 1, and generating hub 14 and needles 8, 9 resistance to distal displacement. Collet 32 is made on hub 14 proximal end. Housing 26 is connected to jaw 2 by plate spring 58 which in a prestart position holds jaws 1 and 2 disconnected, as shown in Fig. 1.

The apparatus is equipped with removable actuator which comprises: actuator housing 33; actuator handle 34 with spring-loaded fixing ball 35 interacting with recess 36 in

actuator housing 33; needle pusher 37 which, being mounted in guide 38, transmits the effort from actuator handle 34 to hub 14 and has in its distal part circular protrusion 39 for engagement with collet 31; actuator housing handle 40. Removable actuator also features means for control of jaws 1, 2 comprising: lever 41, rotatably installed in actuator housing 33 on axle 42 and equipped with working position catch 43, reciprocal spring 44, jaw pusher 45 made as a tube with protrusion 46 for interaction with lever 41 and transmitting effort from lever 41 to jaw 2 for its closing. Actuator housing 33 is connected with apparatus housing 26 through threaded connection 47. Actuator housing 33, needle pusher 37 and jaw pusher 45 may have the length sufficient for apparatus implementation in endoscopic surgeries.

Fig. 2 shows 2-2 section of Fig. 1 drawing which in enlarged scale shows apparatus design as well as the area for connection to detachable actuator with the denominations of Fig. 1.

Figs. 3, 4 show jaw 1 3-3 and 4-4 sections of Fig. 2 in two different points which comprise jaw 3 indented surface, needle guide 24 and slit 48 for PSS bend passing. Jaw 2 (not shown in Figs. 3, 4) has similar members.

Fig. 5 shows the proposed apparatus fragment without actuator as a portion of the apparatus shown in Fig. 1. In idle position jaws 1 and 2 are disconnected under the effect of spring 58. The embodiment shown in Fig. 5 may be connected to removable actuator by thread 60 at the proximal end of housing 26 and collet 32.

Fig. 6 shows assembled detachable actuator as a part of

the apparatus shown in Fig. 1, with appropriate denominations and description. The housing of detachable actuator 33 has at its distal end inner thread 59 for connection to the remaining apparatus.

Fig. 7 shows assembled apparatus in its initial position which also is starting working position. In this position lever 41 is pressed against actuator housing handle 40 and locked against displacement by working position lock 43, spring 44 is extended and jaw pusher is distally moved by lever 41, which results into closing of jaws 1 and 2, compression of hollow organ (not shown in the Fig.) between them and fixation of jaws 1 and 2 in working position.

Actuator handle 34 is disengaged out of its fixed prestarting position, as its catching ball 35 is removed out of recess 36 and shifted distally, thus resulting into entry of pusher 37 circular protrusion 39 into collet 32 and abutting of pusher 37 distal end into hub 14 of needles 8 and 9. In this, the positions of hub 14 and needles 8 and 9 do not change, as they are locked by circular conical protrusion 30, and engagement force of protrusion 30 and apparatus housing 26 exceeds the force necessary for the entry of circular protrusion protrusion 39 into collet 32. In said initial position needles 8 and 9 are located beyond and more proximal of working zone 5, whereas ends 18, 19 of PSS 17 are located beyond and more distal of working zone 5.

Fig. 8 shows fragment of Fig. 7 in enlarged scale, wherein the arrangement of connectors 20, 21 and PSS 17 in the apparatus initial position is illustrated. Connectors 20 and 21 are sited distally of working zone 5 in jaw 1 in buckets

52, 53, respectively, where they are held by friction forces. Entry section 54, 55 of buckets 52, 53 is shaped conically, thus facilitating the entry of needle finite distal sections 12, 13 into connectors 20, 21 during subsequent apparatus operation. There is a slit 56 between buckets 52, 53 devised for passing of thread 57 bend so that slit 56 width is more than PSS 17 thickness. Connectors 20, 21 are tubular shaped. Their distal ends are connected to ends 18, 19 of PSS 17.

In an embodiment shown in Fig. 7, PSS 17 is located on coil 16. In an alternative embodiment (not shown) thread 17 is located in a special cavity, for instance, as a channel located inside the body of jaw 1.

Fig. 9, 10 shows the apparatus during its operation in second position. In this position all control means of jaws 1, 2, including lever 41 and jaw pusher 45, are in the same situation as in the initial position (see Fig. 5). As the result, jaws 1, 2 are closed and hollow organ (not shown in the Fig.) is clamped between them. Actuator handle 34 is displaced by operator into its extreme distal position. As the result, needle pusher 37 transmitting the effort from actuator handle 34 to hub 14 disengaged circular conical protrusion 30 out of conical recess 31 and shifted hub 14 and needles 8, 9 into extreme distal position. In this displacement needles 8 and 9, moving towards stitch pricking direction 50, prick hollow organ and by their finite distal sections 12 and 13 enter into engagement with connectors 20 and 21, respectively. Thus, in the second position, needles 8 and 9 occupy extreme distal position and are partially situated inside jaws 1 and 2, whereas their finite distal sections 12, 13 are located

distally of working zone 5 and connected to connectors 20, 21, which, in their turn, are connected to ends 18, 19 of PSS 17. Therefore, upon arrival into the second position needles 8 and 9 are coupled to ends 18, 19 of PSS 17 by connectors 20, 21, respectively. As Fig. 7 shows, the coupling of needle finite distal sections 12, 13 and connectors 20, 21 is of male-female type, wherein connector proximal portions are made tubular and serve as female members, whereas the connectors themselves have outer diameter equal to outer diameter of 8, 9 needles outside their finite distal sections so that the diameter of needle finite distal sections 12, 13 is less compared to remaining needle portion and they serve as male members. Engagement between male and female members results from friction forces. In alternative embodiments (not shown in the Fig.) needle finite distal sections are made tubular and serve as female members, while connector proximal portions are male members; finite distal section of one needle is female member, whereas finite distal section of the second needle serves as male member by corresponding execution of connector proximal portions - one of them is male member whereas the second one, female; needle finite distal sections as male members have the same outer diameter as the remaining needle portion; in this, the engagement force between needle finite distal sections 12, 13 and connectors 20, 21 exceeds the engagement force between connectors 20, 21 and connector buckets 52, 53, thus allowing to extract connectors 20 and 21 out of their buckets 52, 53 upon subsequent proximal movement of needles 8 and 9, but preserve coupling of needles 8, 9 and connectors 20, 21.

The apparatus special feature is that in its second

position when needles 8 and 9 are in extreme distal position needle 10, 11 pricking tips do not leave the apparatus bounds.

In the apparatus third position (not shown in the Fig.), needles 8 and 9 and adjoint connectors 20, 21 with ends 18, 19 of PSS 17 are located proximally of working zone 5 owing to the displacement of actuator handle 34 into the initial position by operator. In this displacement actuator handle transmits the effort through the actuator pusher 37 and collet 32 onto hub 14 and needles 8, 9, displacing them proximally. Upon transition from the second position into the third one, stitch drawing of ends 18, 19 of PSS 17 in direction 51 takes place through the orifices in hollow organ walls created by prior stitch pricking of hollow organ in direction 50.

The apparatus operation constitutes its transition from prestart position to the first position, and then from the first position into the second one, followed by transition into the third position. Said positions are described above. In the third position circular conical protrusion 30 again enters conical recess 31, thus preventing further distal displacement of hub 14 and needles 8, 9 and permitting extraction of circular protrusion 39 out of collet 32 and setting of actuator handle 34 to prestart position shown in Fig. 1. In the third position needles 8 and 9 do not prevent jaw disconnection made by down pressing of working position lock 43. In this spring 44 returns lever 41 and jaw pusher 45 to the position shown in Fig. 1, and jaw 2 plate spring 58 disconnects jaws 1 and 2. After said disconnection of jaws 1 and 2 by the apparatus proximal movement PSS 17 complete the process of PSS 17 drawing through hollow organ walls. PSS 17,



which in the second position was located on coil 16, upon transition from the second position to the third one and said apparatus subsequent proximal movement gradually leaves coil 16 completely and occupies its position in hollow organ walls.

As the result, ends 18, 19 of PSS 17 are drawn to the hollow organ proximal side, more accessible for a surgeon and more convenient for further PSS tying, which is particularly important for endoscopic surgeries. It brings about advanced operation conditions, reduced time consumption and improved surgery qualities. Besides, since needle pricking tips 10 and 11 do not leave the apparatus bounds, it precludes the hazard of patient organ injury and personnel chance pricking.

Figs. 11, 12 show alternative embodiment of proposed apparatus destined preferably for open surgeries on gastrointestinal tract organs. This alternative embodiment does not differ from that described above in the majority of operation concepts and design elements. Therefore, the description below preserves numerical denominations of similar parts and uses basic notions and definitions given above.

The apparatus comprises two branches 65 and 66, where branch 65 serves as the apparatus housing. Branches 65 and 66 are rotatably connected through axis 67. Jaws 1 and 2 for hollow organ clamping between them are located in their distal part as well as working zone 5. More distal of the working zone removable block 68 containing coil with PSS and connectors is situated in the apparatus housing 65. The apparatus is equipped with closed position lock 69 of branches 65 and 66, when hollow organ stitch pricking and stitch drawing of PSS ends through hollow organ are made. There is

also found spring 70 which ensures disconnection of branches 65 and 66 upon unlocking of their closed position, following stitch drawing of PSS ends, and in prestart position. The apparatus features common hub for needles with handle 71 labelled with sign 72 coinciding with sign 73 in the apparatus second position and sign 74 in its third position. The apparatus is equipped with stripper 75 for removal of PSS ends after stitch drawing of PSS ends through hollow organ walls, i.e. in the apparatus third position, and drawing of PSS ends through hollow organ walls. Similar to the modification described above, the apparatus has hollow organ stitch pricking direction 50 from the working zone proximal border 6 towards its distal border 7, as well as direction 51 of stitch drawing of PSS ends through orifices in hollow organ walls, generated by said stitch pricking from working zone distal border 7 towards its proximal border 6. The apparatus housing 65 is equipped with handle 76, having rest surface 77. When the apparatus arrives into the second position, surface 77 contacts rest surface 78 of handle 71, this being an additional indication of arrival to the said second position.

Fig. 13 shows 13-13 section of the apparatus shown in Fig. 12, whereas Fig. 14 shows 14-14 section of the apparatus shown in Fig. 13. The apparatus shown in Figs. 13, 14 is in its first position. Its block 68 comprises coil 16, PSS 17, and tubular connectors 20 and 21, wherein distal portion is connected to ends 18 and 19 of PSS 17, respectively. Block 68 is easily removable. It is installed into branch 65 by means of mushroom-shaped pins 79 and 80. Besides, thanks to protrusion 81 on block 68 and recess 82 on branch 66, it is

locked in its working positions from longitudinal displacement. More proximal of working zone 5 a bucket 82 of stripper (in Figs. 13, 14 the bucket is shown without stripper) is made in housing 65 (which is at the same time the lower branch) with collet 83 for stripper mounting done in its wall. The zone of PSS exit is adjacent to collet 83 from the distal side and is made as lateral notch 84 on that apparatus side the stripper is being removed from. Needles 8 and 9 are mounted in the apparatus housing 65 and have common hub 14 and guides 85 for hub 14 movement as well as guides 86, 87, 88 and 89 for needles 8 and 9. Hub 14 is equipped actuator made as handle 71. The apparatus has blocking means preventing premature proximal displacement of needles 8 and 9 during the apparatus transition from first position into the second one. These means ensure that needles 8 and 9 will reach extreme distal position in the second position for further reliable engagement of finite distal sections in needles 12 and 13 and connectors 20 and 21. Said means made as a ratchet comprise rack 90 situated on housing 65 wall 91 in distal section of hub 14 progress range, as well as pawl 92 on hub 14. Rack 90 is mounted on elastic foot 93, is thus spring-loaded and has knob 94 for ratchet dislocking in case of emergency. In the second position, by pawl 92 extreme distal position (not shown in Fig. 13, 14) it is located more distal of rack 90 distal end 95. In this, thanks to rack 90 displacement under the action of its foot 93 elastic forces, pawl 92 is shifted towards the reverse, non-indented side 96 of rack 90. As the result, automatic ratchet dislocking occurs in second position, thus ensuring unhindered subsequent transition to

the third position. In the first and third positions hub 14 is kept from arbitrary displacement by stopping collar 97 which, when hub 14 is made plastic, enters recess 98 on branch 65 with definite effort.

Fig. 15 shows the same apparatus as is seen in Figs. 13, 14 but with stripper 75 mounted inside stripper 82 bucket. In doing so, stripper 99 pin comes into engagement with collet 83 and by it holds stripper 75 in bucket 82. In line with needle passages 22, 23 conical channels 100 and 101 (this latter is not shown in Fig. 15) are made in stripper 75, wherein connectors 20 and 21 become embedded at the end of their transition into the third position, owing to the fact that outer surface of connectors 20, 21 is also conical. Said embedding of connectors 20, 21 enables their disconnection from needles 8 and 9 and, following this disconnection, confinement of connectors 20, 21 inside the stripper. Therefore, conical channels 100 and 101 serve as releasing and keeping members at the same time.

The apparatus operation includes transition from the starting first position into the second one where the male-female type engagement between needles 12, 13 finite distal sections (male members) with connectors 20, 21 takes place. Solidity of said engagement is supported by alignment of signs 72 and 73 (see Fig. 11), and/or by contact of abutting surfaces 77 and 78, and/or by rack 90 and pawl 92 operation. Said measures may be applied both in combination and in separate. Upon transition from the first position into the second one stitch pricking of hollow organ by needles 8 and 9 in direction 50 takes place. In doing so, pricking tips

of needles 10 and 11 in the second position do not leave the apparatus bounds. Upon subsequent transition from the second position to the third one, needles 8 and 9 move proximally entraining connectors 20, 21 with PSS 17 ends 18, 19. Stitch drawing of PSS 17 through hollow organ walls takes place in direction 51. Disconnection of needles 8, 9 and connectors 20, 21 occurs distally of working zone 5 in stripper 75. Following disconnection of connectors 20 and 21 and needles 8 and 9 and complete transition to the third position, stripper 75 along with connectors 20, 21 and fixed in them ends 18, 19 of PSS 17 are removed out of apparatus by pressing pin 99. Then the operator pulls stripper 75 and thus completes the drawing of PSS 17 through hollow organ walls. After that, jaws 1 and 2 are freed from catching in closed position by proximal pressing lock 69, which results in their disengagement by spring 70 and permits to release hollow organ from the apparatus. During said hollow organ release PSS also easily leaves the apparatus thanks to lateral notch 84. As the result, PSS 17 ends 18, 19 are drawn to hollow organ proximal side easily accessible and convenient for further PSS tieing, thus improving operation conditions, reducing time consumption and upgrading purse string suture quality. Moreover, as the needle pricking tips 10 and 11 do not leave the apparatus bounds, it precludes the hazard of patient organ injury and personnel chance pricking. Additional increase in operation conveniency, reduction in time consumption and surgery costs is achieved through the opportunity of fast and easy replacement of unit 68 with PSS 17 and connectors. It permits to make several purse string sutures in the same surgery with

the same apparatus.

Fig. 16 shows transversal 16-16 section of the apparatus shown in Fig. 13 which illustrates the design of jaws 1 and 2. Jaws 1 and 2 comprise: their indented surface members - recess 4 on jaw 2 and protrusion 3 on jaw 1; slits 48 and 49 for PSS 17 bend passing; needle guides 24 and 25.

Fig. 17 shows 17-17 section of the apparatus shown in Fig. 13 illustrating lateral notch 84 in housing 65 for PSS 17 exit upon stripper removal from the apparatus. The section also demonstrates guides 88 and 89 for needles 8 and 9, as well as closed position lock 69 for branches 65 and 66.

Figs. 18, 19 show fragment of the apparatus shown in Fig. 15 illustrating stripper 75 arrangement in the apparatus housing 65. Member denominations and their description coincide with those for Fig. 15. Fig. 18 shows stripper 75 before the termination of transition from the second position into the third one, when connector 20 is already embedded in stripper 75 conical channel 100, but needle 12 distal finite portion is not yet disconnected from connector 20. Following termination of transition to the third position, the needle 12 finite distal section, as is shown in Fig. 19, is disengaged from connector 20, and this latter, together with PSS end 18 remains in stripper 75.

Figs. 20...25 show stripper 75 in an alternative embodiment with knife 102 for cutting of PSS ends their release out of the stripper and connectors following termination of PSS drawing through hollow organ walls. Knife 102 is located deep in the recess, which is the only point of access to knife 102. Thanks to it, the personnel is ensured

against injury by knife 102, and chance premature PSS cutting is restricted as well. Stripper 75 also comprises pin 99 for stripper locking in the apparatus housing collet, as well as conical channels 100 and 101 for disconnection of needles and connectors and subsequent connector holding in stripper.

Figs. 26...30 show alternative embodiment of stripper 104 removably installed in housing 65 on needles 8 and 9. Needles 8 and 9 pass through stripper guides 113 and 114, 115 and 116. Stripper 104 is made slightly wider than housing 65, thus enabling the operator to manipulate stripper, while holding it for its lateral surfaces 118 and 119. Springs 105 and 106 are fixed in stripper 104 and equipped with releasing members 107 and 108 intended for disconnection of needle distal finite portions 12, 13 and connectors 20, 21, and with keeping members 109, 110 intended for keeping connectors 20, 21 in stripper 104 following their disconnection from needle distal finite portions 12, 13. Keeping members 109, 110 are equipped with slots 111, 112 for placing PSS ends 18, 19 in them, following locking of back exit out of stripper 104 for connectors 20, 21 by keeping members 109, 110.

Fig. 26 shows apparatus fragment in the first position when releasing members 107, 108 and keeping members 109, 110 are pressed to needles 8 and 9 by elastic forces of springs 105 and 106, respectively, and do not interfere with movement of needles 8 and 9 towards the second position, and partially out of the second position into the third one.

Fig. 27 shows 27-27 section of Fig. 26. Fig. 28 shows the apparatus fragment before termination of transition out of the second position into the third one: connectors enter stripper

104 through orifices 113, 114 and their further progress towards the third position (proximally) is prevented by releasing members 107 and 108; keeping members 109 and 110 cover the orifices 113 and 114 and connectors 20 and 21 cannot now leave stripper 104 through them. Fig. 29 shows 29-29 section of Fig. 28, additionally illustrating mutual member arrangement described. Upon further progress of needles 8, 9 towards the third position they disconnect from connectors 20, 21 and those latter, as is shown in Fig. 30, remain in stripper 104 together with PSS ends 18, 19, whereas stripper 104 per se is easily extracted from the apparatus.

Figs. 31-33 show alternative embodiment of stripper 117 set inside housing 65 on needles 8 and 9 passing through stripper 117 channels 118 and 119. Each channel 118 and 119 has four protrusions 120 and 121, which serve as keeping members. Protrusions 120 and 121 interact with conical circular protrusions 122 and 123 on connectors 20 and 21, respectively, and keep connectors from distal falling out of stripper 117. In alternative embodiment of Fig. 31 the function of releasing members is fulfilled by ends 124 and 125 of needle guides 86 and 87 in housing 65. In this, connectors 20 and 21 have sections with larger diameter than that of guides 86 and 87. These sections abutt ends 124 and 125 upon movement of needles 8 and 9 to the third position. As the result, needles 8, 9 are disconnected from connectors 20 and 21. Fig. 31 shows the apparatus fragment before said disconnection, whereas Fig. 33 shows stripper 117 following said disconnection. In third position, stripper 117 with connectors 20, 21 and PSS ends 18, 19 is easily taken out of



the apparatus.

Figs. 34, 35 show removable unit 68 of apparatus shown in Figs. 13...15 on an enlarged scale. Unit 68 comprises coil with PSS and connectors and is equipped with mushroom-shaped pins 79 and 80, as well as protrusion 81 for fixation inside the apparatus. Unit 68 has cover 126, whereunder coil with PSS is placed.

Figs. 36...38 show a fragment of jaw 1 of the apparatus shown in Fig. 13, located distally of working zone 5 and comprising unit 68 bucket 127 and geometrical orifices 128 and 129 for inside installation of mushroom-shaped pins 79 and 80, respectively. To install unit 68 into bucket 127, mushroom-shaped pins are inserted into orifices 128 and 129, and then unit 68 is sifted distally. In this process, heads of mushroom-shaped pins 79 and 80 enter niches 130 and 131, which results in unit 68 fixation in bucket 127. Fig. 38 demonstrating 38-38 section of Fig. 36.

Figs. 39...41 show hub 14 of needles 8 and 9 of the apparatus given in Figs. 13..25 on an enlarged scale. Hub 14 comprises actuator handle 71, pawl 92 for interaction with rack 90 (see Fig. 13), recess 132 for rack 90 passing, protrusion 97 for hub 14 fixation in first and third positions. Hub 14 interaction with other apparatus members is given in the description of Figs. 13...15.

## CLAIMS:

1. An apparatus for purse string suturing of hollow organ which being mounted inside the apparatus has two lateral sides, comprising:

- purse string suture (PSS) which is drawn through the walls of said hollow organ;
- means for stitch pricking of said hollow organ wall and stitch drawing of said PSS through this wall;
- direction of stitch pricking;
- direction of PSS stitch drawing through orifices in said hollow organ wall, generated by said stitch pricking;
- so that said direction of PSS stitch drawing is opposite to the said direction of stitch pricking.

2. The apparatus according to claim 1, wherein:

- said PSS has ends;
- said means for stitch pricking and PSS stitch drawing include piercing means;
- working zone is available wherein stitch pricking of said hollow organ wall and stitch drawing of said PSS ends through it are performed;
- initial position is found, when said PSS ends are located on one side of said working zone, whereas said piercing means, on its opposite side.

3. The apparatus according to claim 2, wherein:

- there is a pair of jaws and within their bounds said working zone is situated so that clamping of said hollow organ between said jaws takes place for stitch pricking of its wall and said PSS stitch drawing;
- said jaws and said working zone have proximal side

whereon stitch pricking of the wall of said hollow organ originates, and distal side whereon stitch drawing of said PSS ends originates;

- in said initial position said PSS ends are situated from said distal side of said jaws, whereas said piercing means are situated from said proximal side of said jaws outside said working zone.

4. The apparatus according to claim 3, wherein:

- said piercing means are made as two needles;  
- there are connecting means for connection of said PSS ends and said needles.

5. The apparatus according to claim 4, wherein there are needle ways in said jaws where each said needle has pricking tip with adjacent finite distal section of said needle, whereas said needles, jaws and PSS ends are situated relative to each other in the following manner:

- first position, which is said initial position: said needles are positioned outside and more proximally of said working zone;

- second position, which is extreme distal position of said needles: said needles are partially positioned inside said working zone and said pricking tips of said needles and said finite distal sections of said needles are located more distally of said working zone and are connected to said PSS ends:

- third position which takes place after return of said needles from said second position: said needles and said PSS ends drawn through said hollow organ wall are located more proximal of said working zone.

6. The apparatus according to claim 5, wherein said connecting means are made as two pairs of members, each of them comprising said needle finite distal part and connector, wherein distal part is the fixation point of said PSS end, whereas proximal part is adapted to engaging with said needle finite distal section.

7. The apparatus according to claim 6, wherein said engagement of said connector and said needle finite distal part is made on male-female principle.

8. The apparatus according to claim 7, wherein proximal part of said connector is tubular and operates as female member, whereas said needle finite distal section is male member.

9. The apparatus according to claim 7, wherein engagement of said needles and connectors takes place owing to friction forces.

10. The apparatus according to claim 7, wherein there are engagement means for engaging said needles with said connectors so that said engagement means comprise at least one recess and one protrusion and so that one of them is situated on said needle finite distal section, while the other one, on connector.

11. The apparatus according to claim 7, wherein there are seat buckets for installation of said connectors inside them, and said buckets are situated more distal of said working zone.

12. The apparatus according to claim 7, wherein the couplings of said connectors and said needles are needles are undetachable.

13. The apparatus according to claim 7, wherein the coupling of said connectors and needles is made detachable and their disengagement occurs more proximal of said working zone during their movement from said second position to said third position so that progress of said needles upon said motion is larger than said connector progress by at least axial overlapping value of said needles and connectors in their second position.

14. The apparatus according to claim 13, wherein there are means for disconnection of said connectors and needles, located more proximal of said working zone.

15. The apparatus according to claim 14, wherein said means for disconnection comprises releasing members for disconnection of said connectors and said needles.

16. The apparatus according to claim 15, wherein said releasing members are rigid, made as steps adapted to engagement with said connectors with the force sufficient for removal of said connectors from said needles.

17. The apparatus according to claim 15, wherein said releasing members are made elastic and comprise engaging edges adapted to engagement with said connectors for its removal from said needles.

18. The apparatus according to claim 15, wherein there is a stripper removably installed in the apparatus and adapted to: confinement of said connectors with said PSS ends in said connectors following disconnection of these latter from said needles; removal of said connectors with said PSS ends from the apparatus and PSS drawing through said hollow organ walls; and containing keeping members preventing backward exit of.

said connectors with said PSS ends out of said stripper following their disconnection of said needles, and there is a bucket for stripper made as a recess in apparatus members.

19. The apparatus according to claim 18, wherein said keeping members look like spring-loaded members shutting backward exit of said connectors following their entering the said stripper and made as, for instance, springy-steel bended plate members.

20. The apparatus according to claim 18, wherein said releasing members are situated inside said stripper.

21. The apparatus according to claim 18, wherein said keeping members are at the same time releasing members and are made as, for instance, cone-shaped channels with their widened side directed distally, and adapted to embedding of said connectors inside them.

22. The apparatus according to claim 15, wherein engagement forces of said connectors with said releasing members are larger than engagement forces of said needles and said connectors, whereas said engagement forces of needles and connectors are larger than any forces counteracting the movement of said connectors upon progress of said needles from said second position to said third position until the moment of said connectors and releasing members interaction.

23. The apparatus according to claim 5, wherein there are means promoting achievement of said extreme distal position by said needles in said second position, and thus ensuring reliable connection of said PSS ends and said needle finite distal sections.

24. The apparatus according to claim 23, wherein there are

support surfaces on apparatus immovable members, and movable support surfaces on its movable members connected with said needles upon their progress from said first position into said second one so that said movable support surfaces during said needle progress move toward said immovable support surfaces and they abutt each other in extreme distal position of said needles.

25. The apparatus according to claim 23, wherein there are means for interlocking the said proximal displacement of needles towards their said third position until the needles reach their said extreme distal position in said second position but so that said interlocking means act at least in distal portion of said needle progress limited by their first and second positions; as well as means for unlocking the said needle proximal displacement.

26. The apparatus according to claim 25, wherein said interlocking means are made as a ratchet comprising rack and pawl, one of them being spring-loaded.

27. The apparatus according to claim 5, wherein there are means for achievement of said extreme proximal position by the needles in their said third position.

28. The apparatus according to claim 27, wherein there is immovable support surfaces on apparatus immovable members, and movable support surfaces on its movable members connected with said needles upon their movement from said second position into said third one so that said movable support surfaces during said needle progress move toward said immovable support surfaces and they abutt each other in extreme proximal position of said needles.

29. The apparatus according to claim 4, wherein there is an apparatus casing containing said jaws in its distal part, and said needles are located in said apparatus casing more proximal of said working zone upon said initial position; said casing comprises guides and actuator for said piercing means as well as control means for said jaws.

30. The apparatus according to claim 29, wherein said actuator is removable and comprises: actuator casing; actuator casing handle; pusher for transmission of effort to said piercing means; as well as said control means for said jaws.

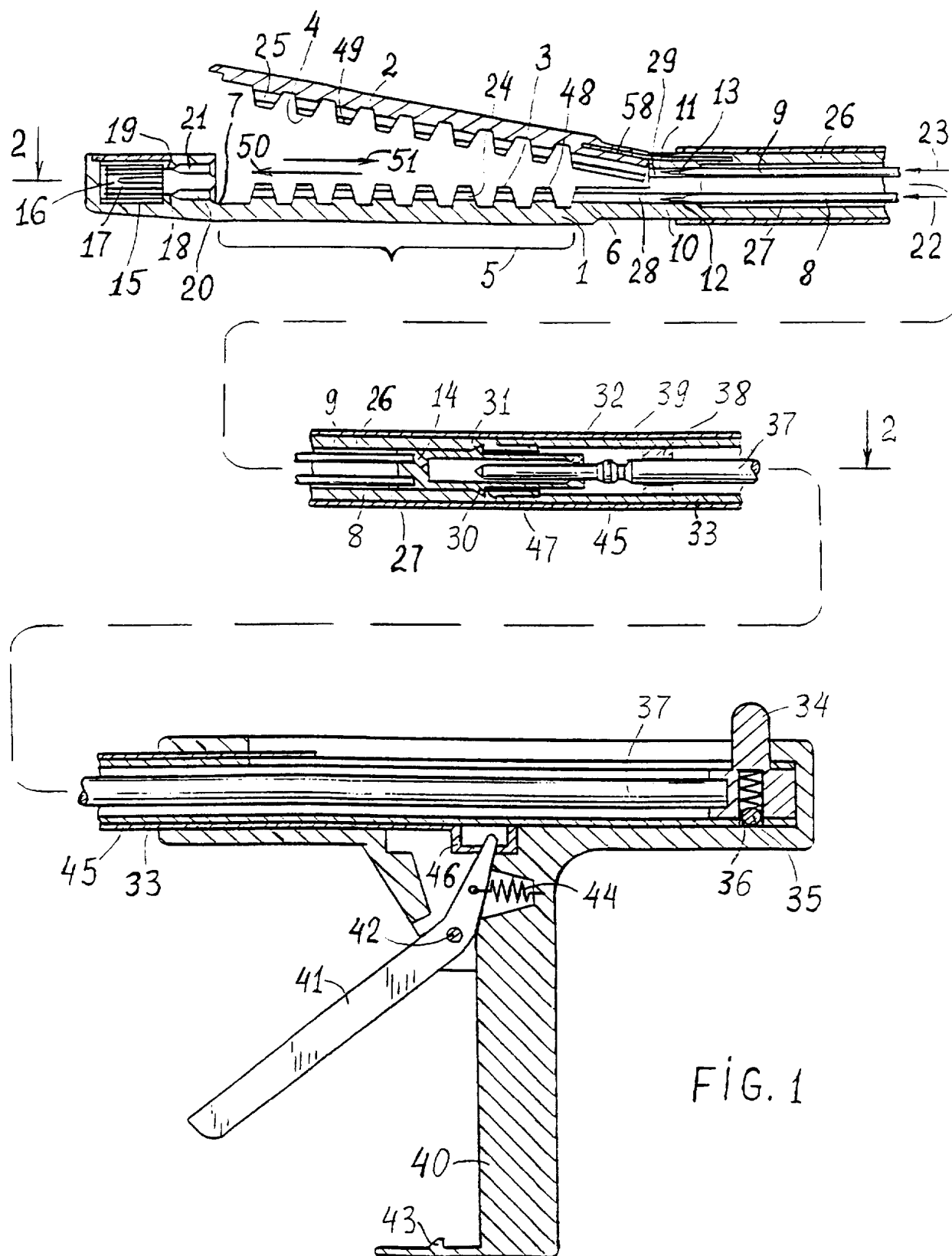
31. The apparatus according to claim 6, wherein there is a separate, detachable member whereon said PSS and said connectors are mounted.

32. The apparatus according to claim 18, wherein said stripper is equipped with knife for cutting said PSS and their liberation in said manner from said stripper and connectors.

33. The apparatus for purse string suturing of hollow organs according to any of 1 - 32 claims, substantially as shown and described in connection with any of 1 - 63 Figs.



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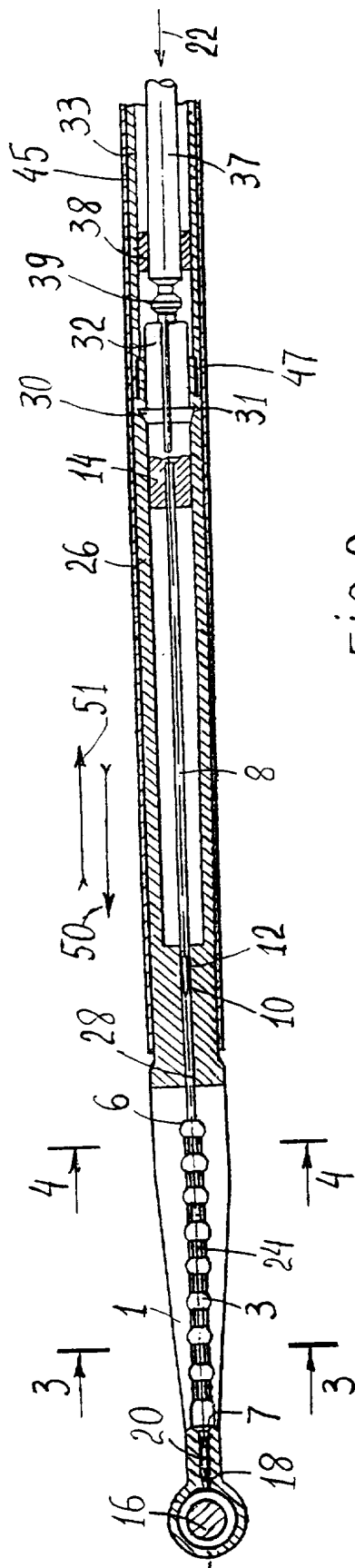


FIG. 2

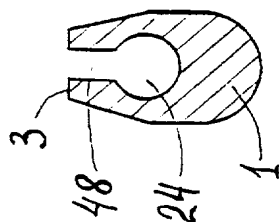


Fig. 3

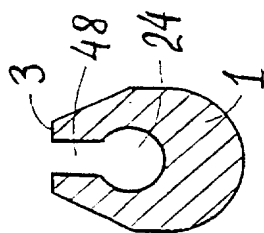


FIG. 4

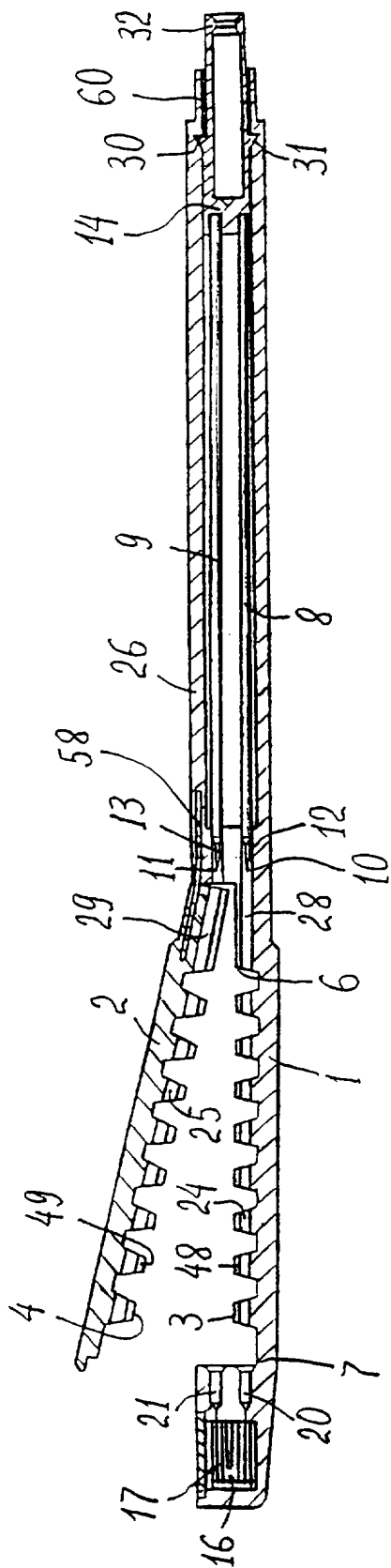


FIG. 5

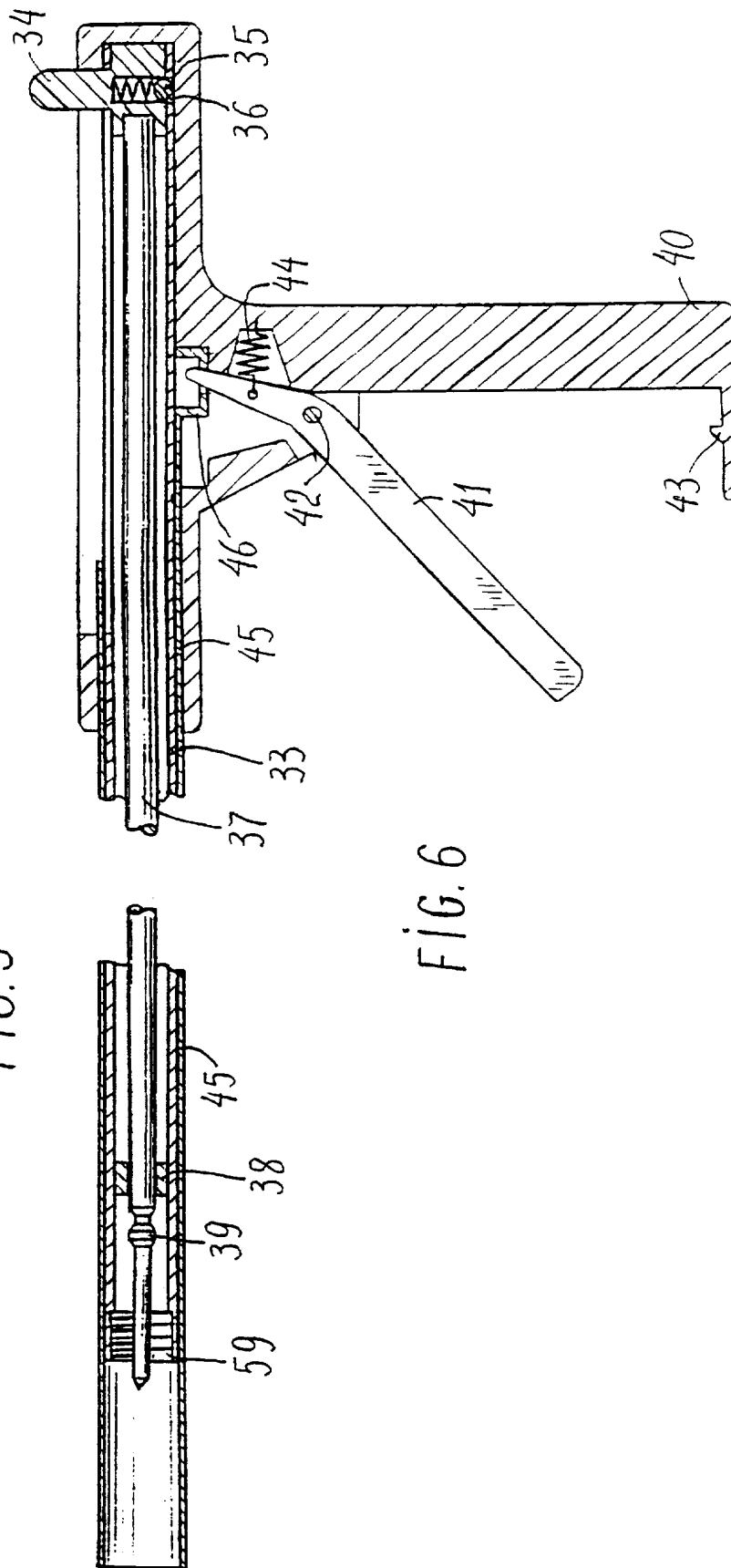
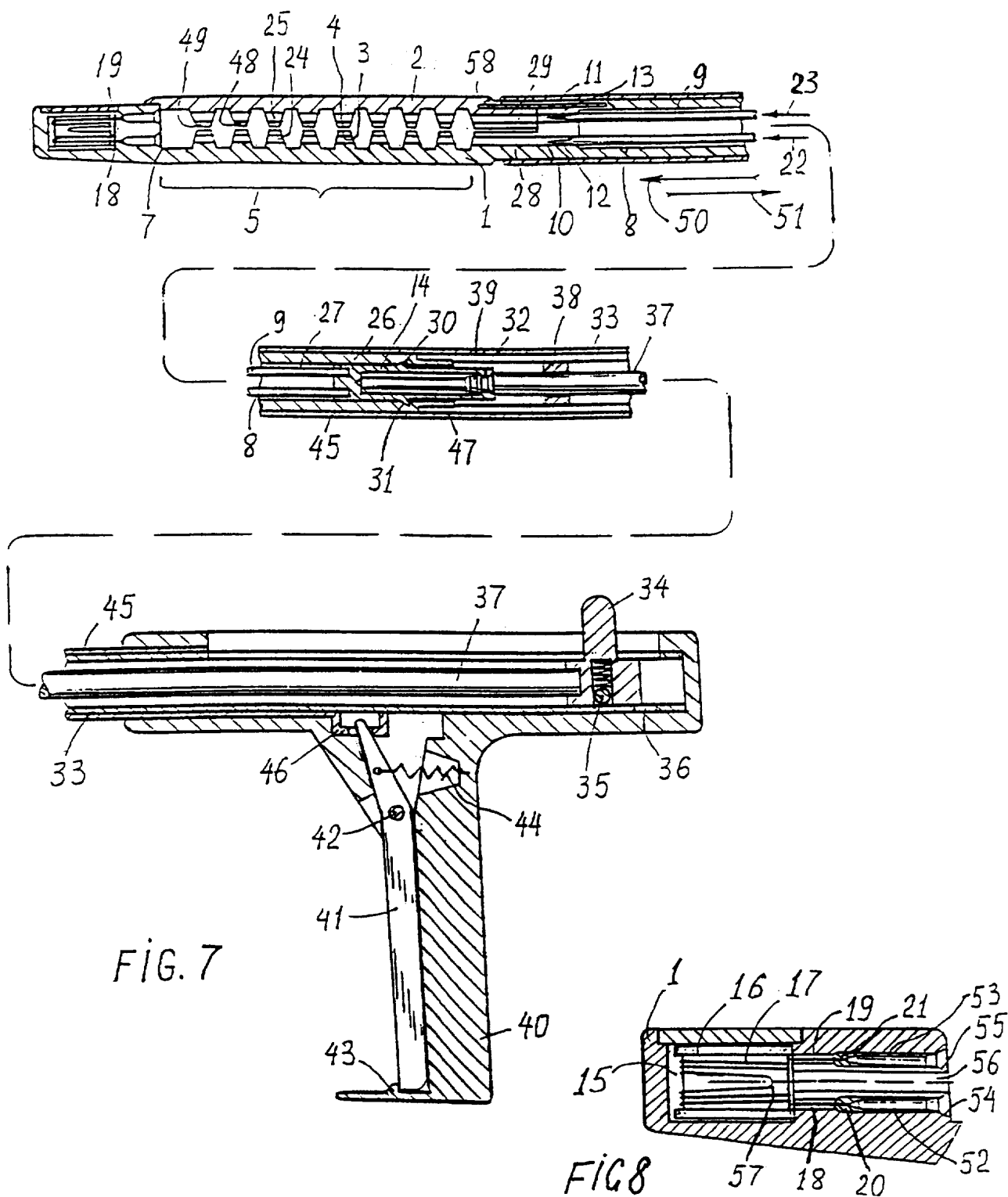
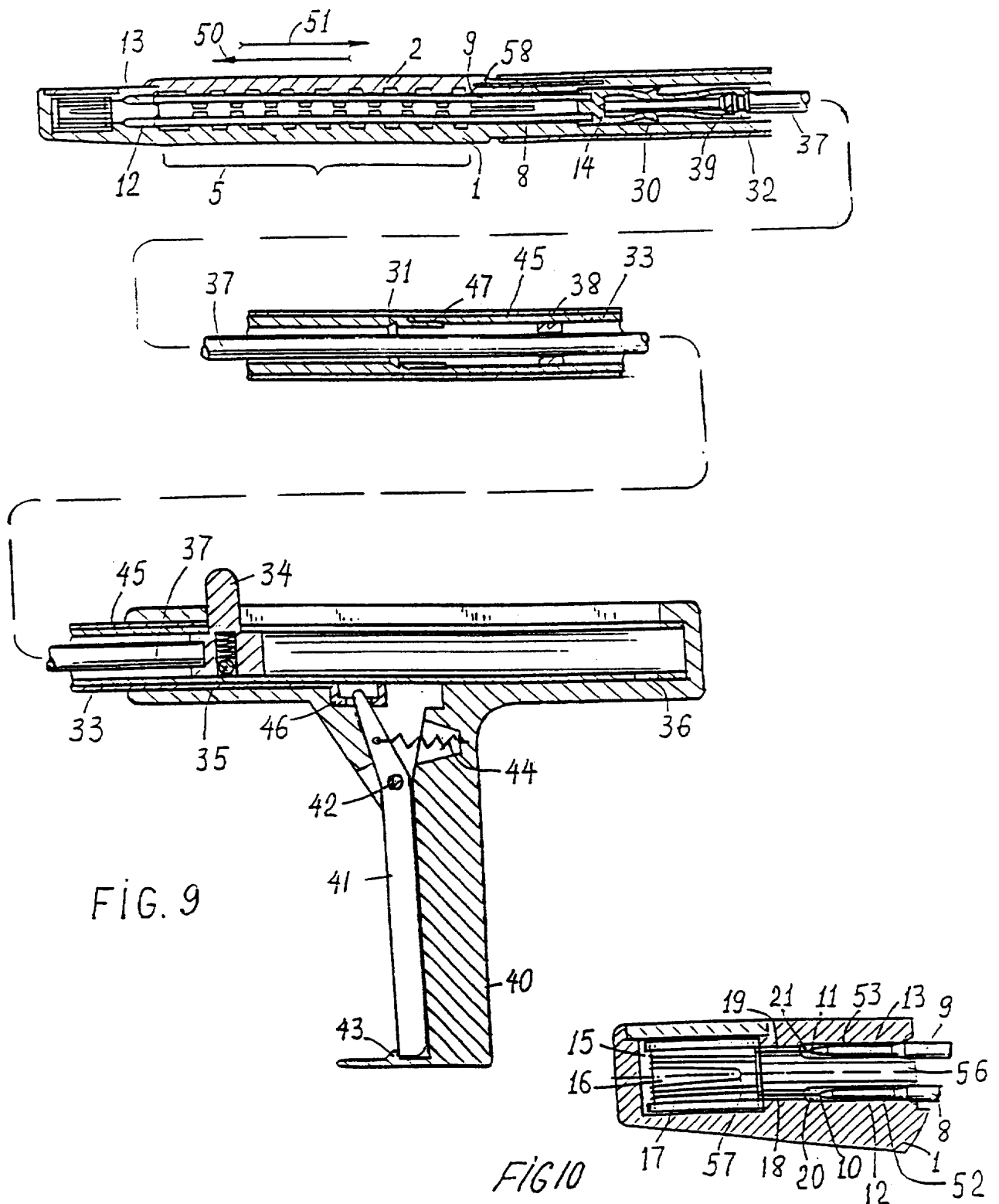


FIG. 6





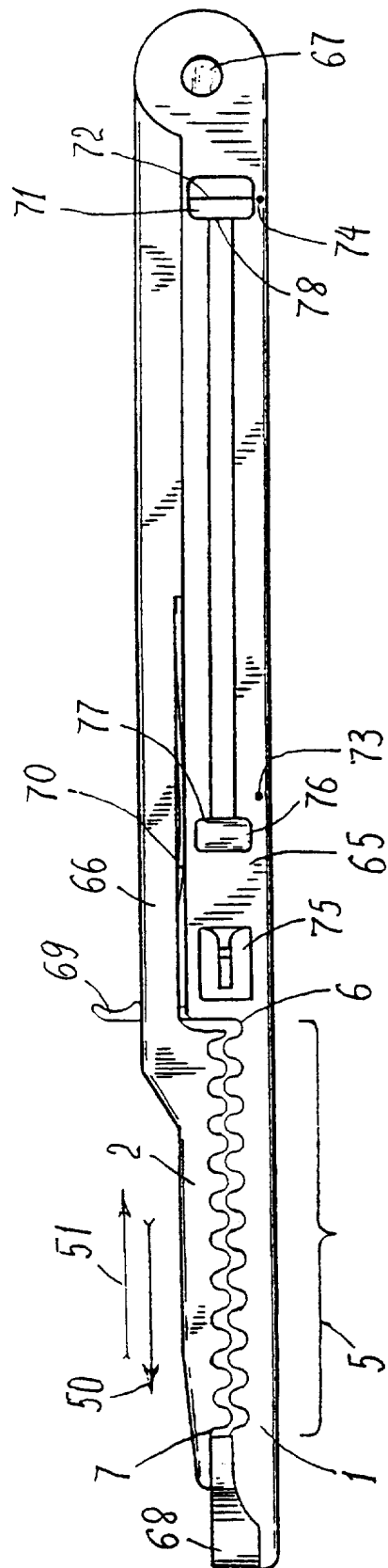


FIG. 11

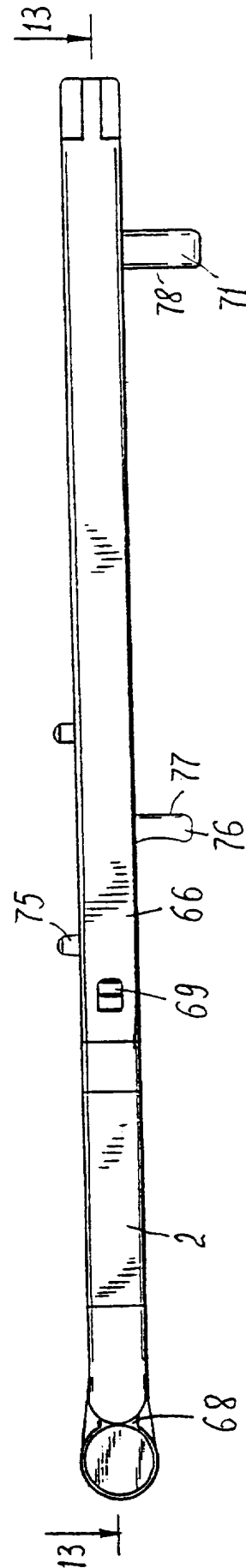
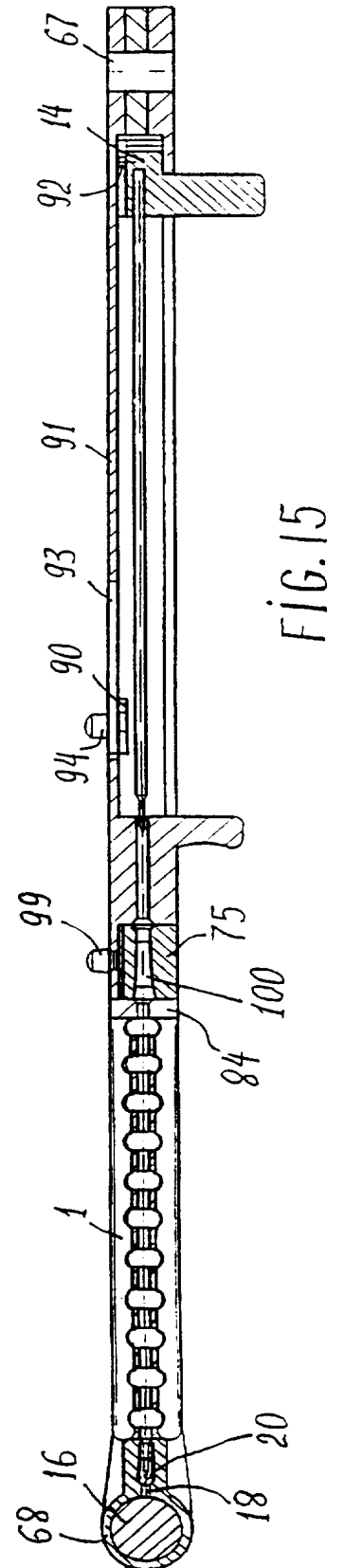
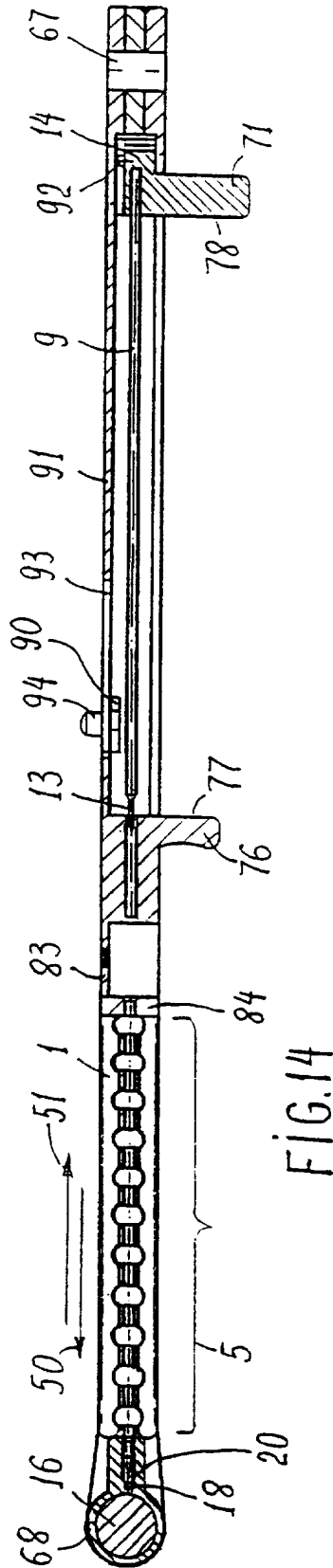
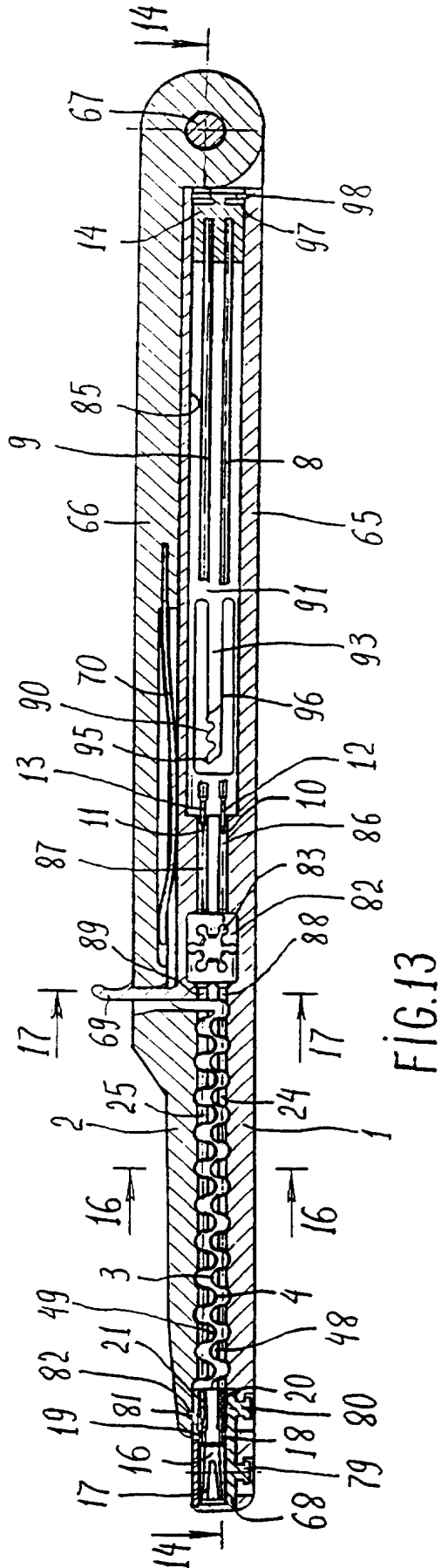


FIG. 12



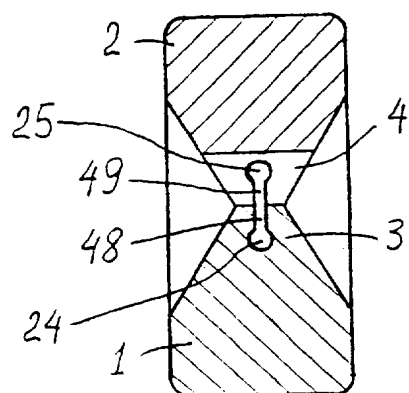


FIG. 16

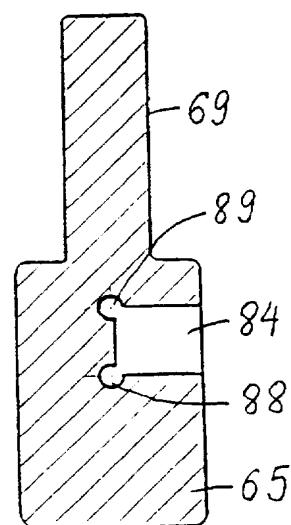


FIG. 17

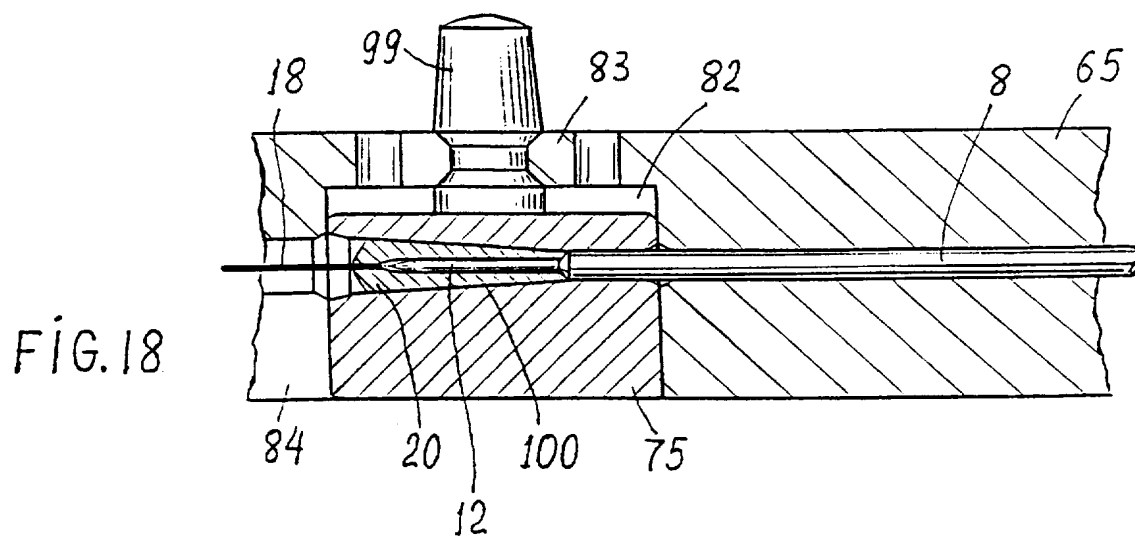


FIG. 18

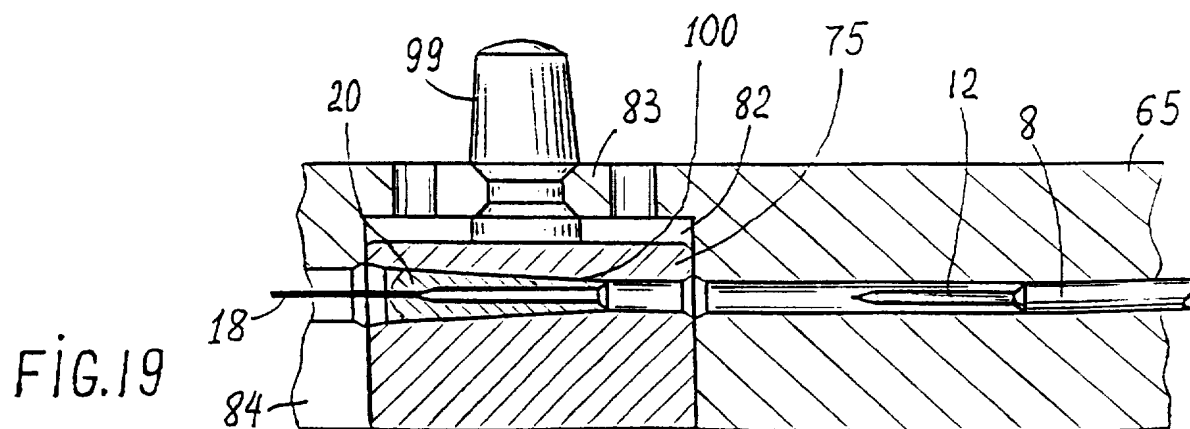


FIG. 19



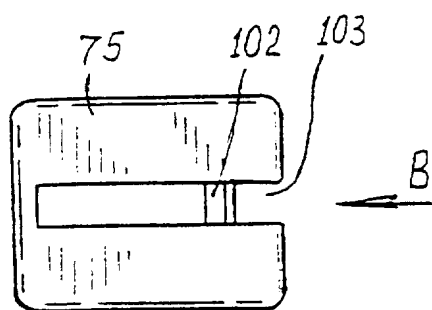


FIG. 20

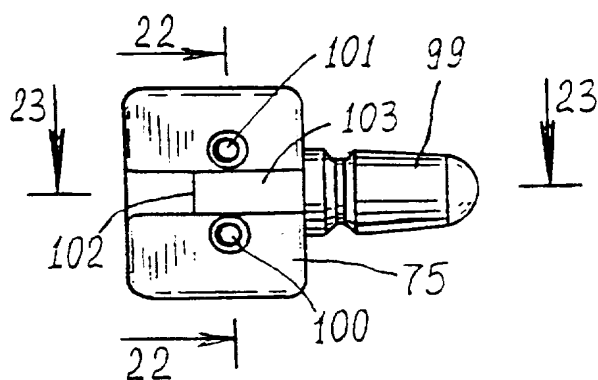


FIG. 21

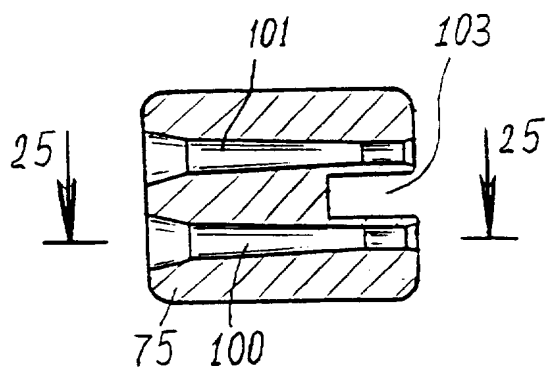


FIG. 22

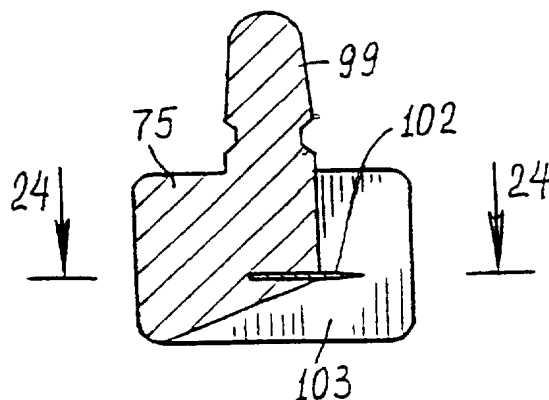


FIG. 23

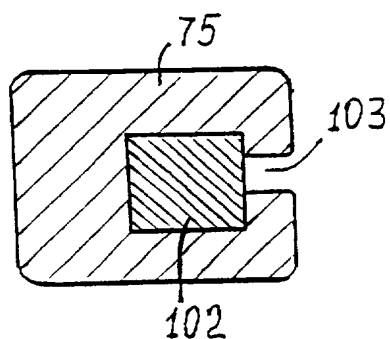


FIG. 24

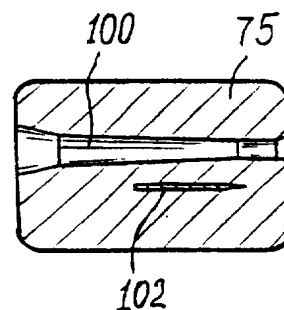


FIG. 25

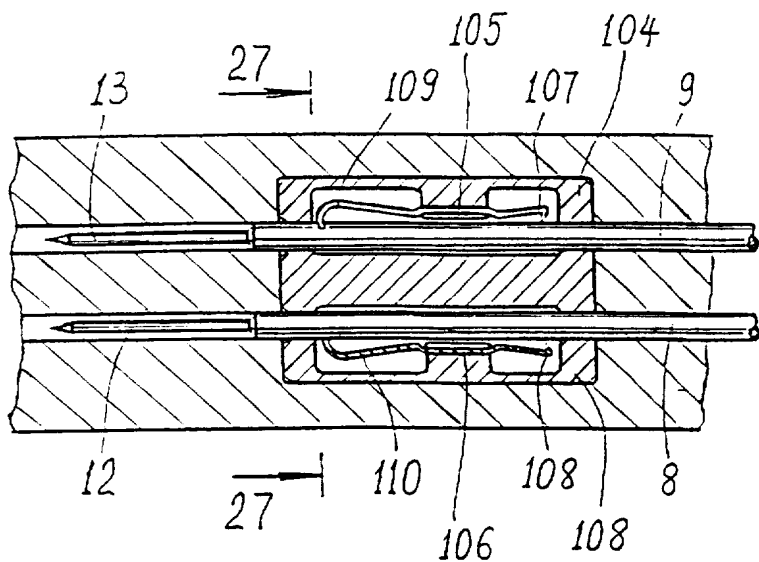


FIG. 26

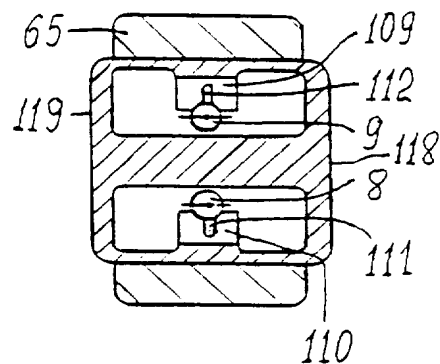


FIG. 27

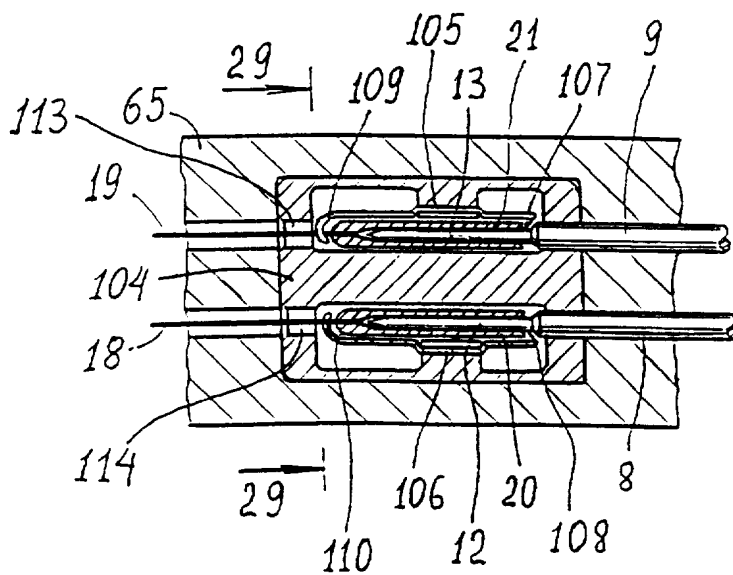


FIG. 28

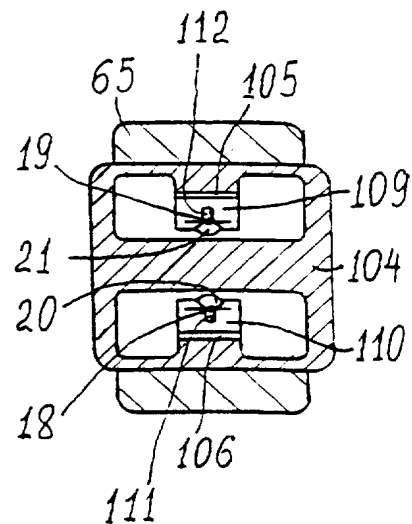


FIG. 29

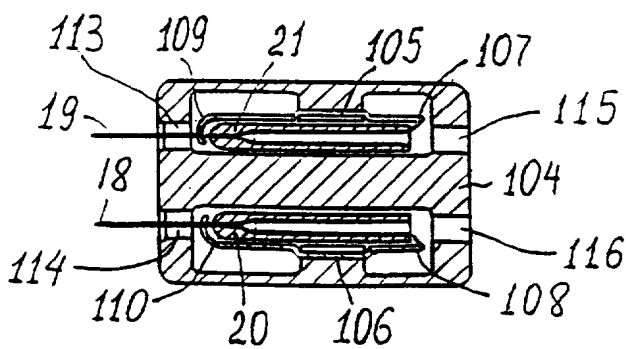


FIG. 30

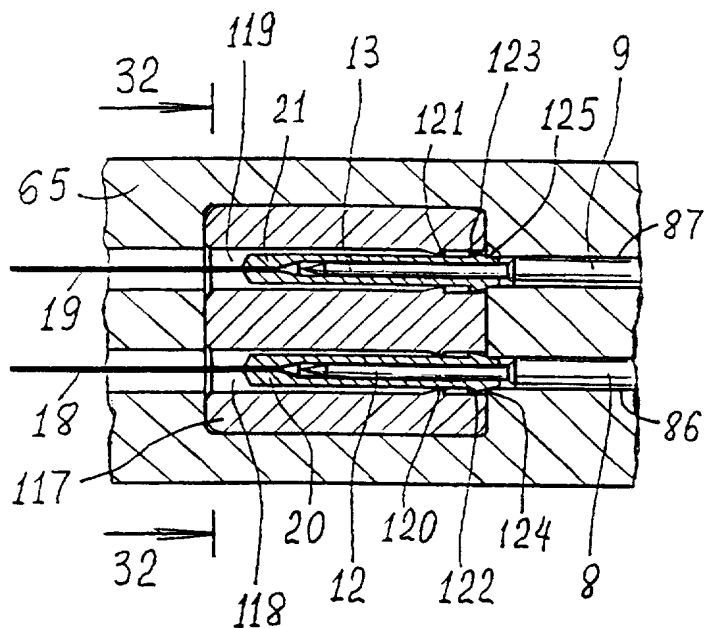


FIG. 31

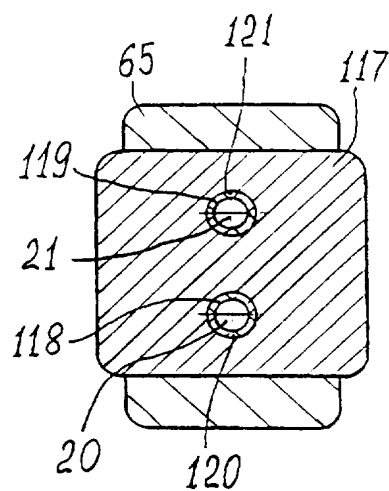


FIG. 32

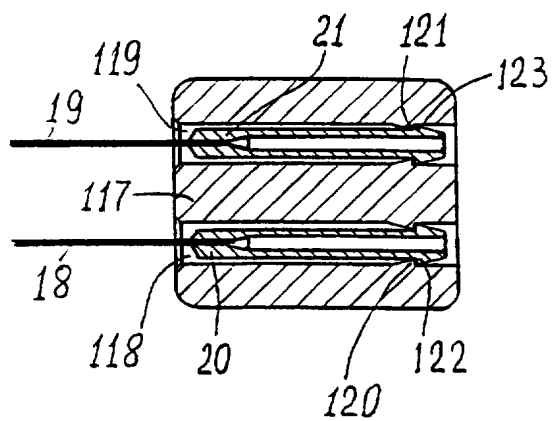


FIG. 33

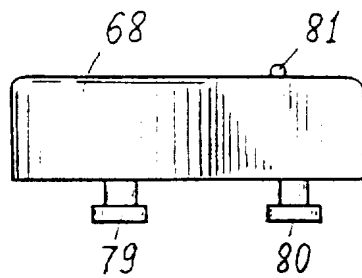


FIG. 34

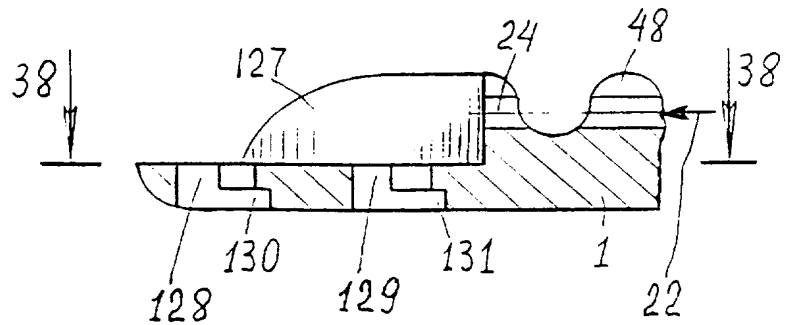


FIG. 36

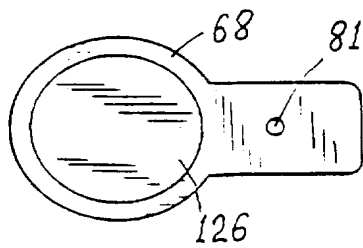


FIG. 35

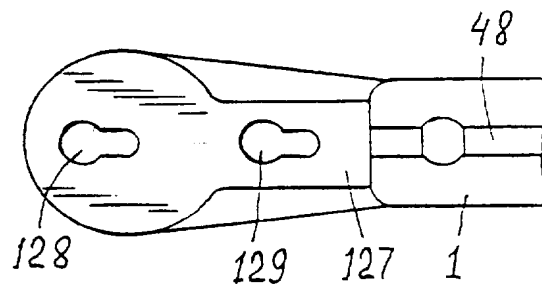


FIG. 37

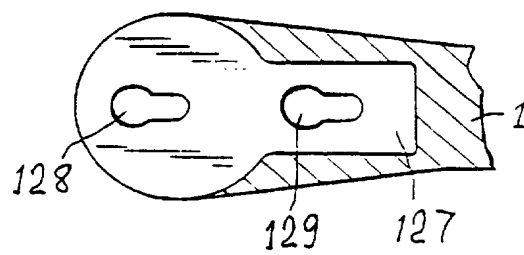


FIG. 38

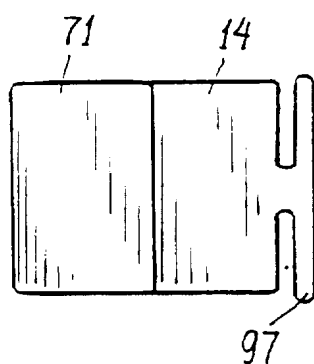


FIG. 39

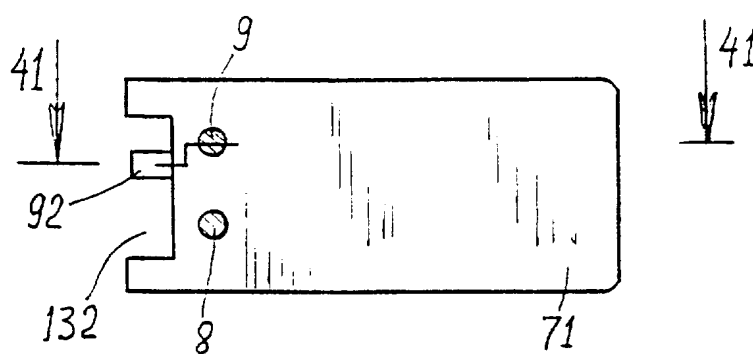


FIG. 40

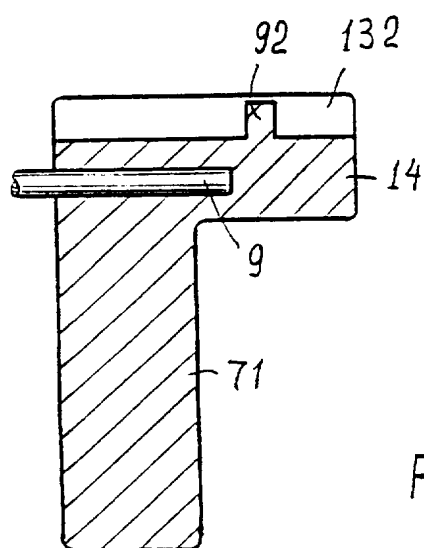


FIG. 41

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/IL97/00253

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A61B/ 17/04

US CL :606/144

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 606/139, 144, 145, 148

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, P	US 5,562,686 A (SAUER et al.) 08 October 1996, entire document.	1-13, 23-25, 27-30, 33

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" Inter document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"B" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Z" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 10 NOVEMBER 1997	Date of mailing of the international search report 02 DEC 1997
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